Competency 2.2 **Radiation protection personnel shall demonstrate a working level knowledge of the following Federal regulations, codes, policy, and Department of Energy (DOE) Orders, notices and standards related to radiation protection:**

- **DOE Policy 450.2A, *Identification, Implementation, and Compliance with Environmental, Safety and Health Requirements***
- **DOE Order 5400.5, *Radiation Protection of the Public and the Environment,* or when promulgated, 10 CFR 834*, Radiation Protection of the Public and the Environment and associated Implementation Guides***
- **DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards***
- **DOE Order 232.1, *Occurrence Reporting and Processing of Operations Information***
- **DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities***
- **DOE/EH-0256T, (Revision 1), Department of Energy *Radiological Control Manual***

1. SUPPORTING KNOWLEDGE AND /OR SKILLS

a. Describe the relevant requirements, interrelationships and importance of the listed Orders, notices, codes, and regulations, guides, technical manual(s).
b. Discuss the role of radiation protection personnel with respect to these Orders and regulations.
c. Discuss how Conduct of Operations is applied to radiation protection activities.
d. Discuss how the *Radiological Control Manual* is now applied (i.e., as a requirement or as a technical standard) in your program, or at the site(s) or facility(s) for which you have responsibility.
e. Discuss the following as they relate to occurrence reporting:
   - How soon after an event or condition is identified must it be categorized.
   - Who must be notified at the facility where it occurred.
   - The two broad groups or conditions in which a health physicist would likely be involved in identifying the reportable event.

2. SUMMARY

DOE Documents Related to Radiation Protection

The DOE Directives System includes a hierarchy of documents that describe how the Department does work. There are four levels of documents in the hierarchy:

- Policy (Why we do it)
- Requirements (What must be done)
- Guides (DOE acceptable methodologies)
- Technical standards (How to)

DOE Policy 450.2A, ***Identifying, Implementing, and Complying with Environment, Safety and Health (ES&H) Requirements***	
Purpose	Reaffirms the DOE commitment to Nuclear Safety policy.
Scope	Protect workers and public environment.
Requirements/ Key Words	Identification of Requirements Includes the integrated review of safety requirements with a disciplined analysis of the work to be performed and the potential hazards associated with that work, and the operational and administrative operations required to conduct that work safely. The transition of Orders must be managed so as to ensure adequate protection throughout. Implementation of Requirements Adequate protection should be maintained at the diverse facilities throughout the DOE complex. Implementation of requirements should be tailored to reflect the circumstances of a particular workplace. To maintain continuity of existing efforts, advantage of implementation efforts already completed or where past efforts reflect integrated approaches to safety management and the development of S/RIDs or the necessary and sufficient process should be taken. Contractors that will not be in compliance with rule requirements on or near the applicable regulatory deadline for compliance must seek an exemption in accordance with provisions of 10 CFR 820, Guidance documents will be developed and issued concurrently with the development of requirements. Compliance with Requirements Cooperative efforts should result in contractor performance that satisfies requirements. If they do not, DOE will seek compliance through the use of regulatory and contractual enforcement tools.

DOE Policy 450.2A, sets forth the framework for ES&H requirements so that work is performed in the DOE Complex in a manner that ensures an adequate protection of the worker, the public, and the environment. This includes:

- Integrated review of safety requirements.
- Transition to rules and revised orders.
- Ensuring adequate protection at diverse facilities.
- Continuity of ongoing efforts.
- Implementation plans.
- Guidance documents (including technical standards).
- Compliance with requirements by contractual mechanisms and nuclear safety requirements.
- Enforcement of compliance through contractual mechanisms and civil and criminal penalties.

DOE Order 5400.5, *Radiation Protection of the Public and the Environment* **NOTE:** DOE Order 5400.5 is due to be superseded by 10 CFR 834, *Radiation Protection of the Public and the Environment.*	
Purpose	Protects the public and the environment against undue risk of radiation due to operations of DOE and DOE contractor facilities.
Scope	All DOE elements and contractors.
Requirements/ Key Words	Chapter I, General Summary DOE is primarily adopting the Internal Commission on Radiological Protection (ICRP) 26/30 system of dose calculation, limitation, etc. The DOE primary standard is 100 mrem effective dose equivalent (EDE) in a year above background to members of the public from all pathways and sources. (This is reduced from the previous primary standard of 500 mrem in a year since it is already largely being achieved and it follows the ICRP recommendation.) Chapter II, Requirements for Radiation Protection of the Public and the Environment The primary limit of 100 mrem EDE in a year is described in detail. The limit includes all pathways and sources and internal and external exposure from routine operations. It does not include doses received from occupational exposures, accidental unplanned releases, naturally occurring background radiation, medical radiation, consumer products, or fallout. If justified, the public dose limit can be temporarily increased to 500 mrem through a request to EH-1. Chapter III, Derived Concentration Guides (DCGs) for Air and Water DCGs are concentrations of a radionuclide in air or water that, under conditions of continuous exposure for one year by one exposure mode (e.g., ingestion of water), would result in an EDE of 100 mrem. These are not limits, but tools to be used in meeting the basic requirements. Chapter IV, Residual Radioactive Material Residual Radioactive Material: • Originally issued as guidance for Formerly Utilized Sites Remedial Action Program (FUSRAP) and Surplus Facilities Management Program (SFMP). • Chapter IV of DOE Order 5400.5 now applies DOE-wide. • Basic dose limit is 100 mrem above background EDE in a year due to residual radioactive material. It is expected that the potential doses associated with actual or likely use of the released property will be a few mrem or less. This limit applies to all sources and pathways (excluding background and medical). The limits for radon and radon progeny are addressed separately. • Guidelines for residual radioactive material in soil shall be derived by environmental pathway analysis except for thorium (Th) and radium (Ra). The RESRAD computer program is recommended, but alternate procedures are acceptable.

Environmental requirements for facility operations such as permissible public doses, limits on effluent discharge and the release of waste from DOE sites are stated in DOE Order 5400.5 soon to be modified and released as 10 CFR 834.

DOE Order 5400.5 establishes standards and requirements for operations of DOE and its contractors with respect to protection of the public and the environment against undue risk from radiation. The Order is divided into four chapters that discuss the general topics covered in the Order, requirements for radiation protection of the public and the environment, derived concentration guides (DCGs) for air and water, and residual radioactive material.

Chapter I, General Summary

The first chapter serves as a general introduction. The chapter highlights Internal Commission on Radiological Protection (ICRP) recommended methodology, the DOE primary dose standard, the ALARA philosophy, treatment technologies, and compliance with the Order.

Specifically, DOE:

- Adopts the ICRP 26/30 methodology recommended in 1977. (**NOTE**: Since the issuance of DOE Order 5400.5, the ICRP has published new recommendations on radiation protection, ICRP 60.)
- Uses a primary dose standard of 100 mrem in a year. This is an effective dose equivalent (EDE) from all sources and all pathways. (An EDE [H_E] is the summation of the products of the dose equivalent received by specified tissues of the body and the appropriate weighting factors. It includes the dose from radiation sources internal and/or external to the body. The EDE is expressed in units of rem or sievert [Sv].)
- Adopts the As Low As Reasonably Achievable (ALARA) principle. This means that in this Order, ALARA is no longer a recommended practice, but a required part of the radiation protection program (RPP). ALARA is an approach to radiological control to manage and control exposures (individual and collective) to the workforce and to the general public at levels as low as is reasonable taking into account social, technical, economic, practical, and public policy considerations. ALARA is not a dose limit, but a process that has the objective of attaining doses as is reasonably achievable in each program and in each operation.
- Adopts the Best Available Technology (BAT) as the appropriate level of treatment for liquid wastes at the point of discharge. BAT selection uses different factors to determine the best technology that can be used to treat liquid wastes. Some of these factors include the age of the facility; the cost of the technology; and environmental, safety, and public impacts of the technology.

- Calls for the phasing out of soil columns to prevent contamination in soils and groundwater, thereby protecting the environment. Soil columns include trenches, cribs, ponds, drain fields, or other methods that retain, by sorption or ion exchange, suspended or dissolved radionuclides from liquid waste streams.
- Requires compliance with the Order through effluent monitoring (measuring quantities and concentrations of liquid and airborne discharges), environmental surveillance (establishes background level of pollutants, determines the location and magnitude of pollutant concentrations), and assessments using prescribed models and dose conversion factors.

Chapter II, Requirements for Radiation Protection of the Public and the Environment

The primary dose limit for members of the public is 100 mrem EDE in a year from all sources and all pathways. The EDE was originally defined by the ICRP when they introduced a risk-based system in ICRP 26. The EDE allows the summation of external and internal doses. The primary dose limit, therefore, includes exposures from sources external to the body during the year and the committed EDE from radionuclides taken into the body during the year. This limit does not apply, however, to doses from medical exposures and consumer products. The limit does not generally apply to naturally-occurring radioactivity and accident conditions. Authorization to exceed the primary standard is possible, but requires approval from DOE officials (EH-1).

Other limits specified in this chapter are:

• Airborne emissions (40 CFR 61)	10 mrem (0.1 mSv) EDE
• Spent nuclear fuel, high-level, and transuranic wastes (40 CFR 191)	25 mrem (0.25 mSv) whole body 75 mrem (0.75 mSv) any organ
• Drinking water (40 CFR 141)	4 mrem (0.04 mSv) EDE at the tap 5E-9 µCi/ml (Ra-226 + Ra-228) 1.5E-8 µCi/ml gross alpha

The regulation of airborne emissions is required under the Clean Air Act, which, in turn, precipitated the issuance of 40 CFR 61, *National Emission Standards for Hazardous Air Pollutants*. The airborne limit of 10 mrem is based on releases to the atmosphere from routine DOE activities. Exposures from radon-220 (Rn-220), Rn-222, and their progeny are subject to separate Federal limits.

NOTE: The limits for spent nuclear fuel facilities, etc. are not in EDE units since both whole body and organ doses are specified. Simply stated, 40 CFR 191, *Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level, and Transuranic Radioactive Wastes*, was written several years ago using ICRP 2 methodology, which treated external and internal doses separately.

The drinking water limits in this Order are based on 40 CFR 141, *National Interim Primary Drinking Water Regulations* (Safe Drinking Water Act), a regulation that was also written prior to the advent of the EDE. However, it is listed here as an EDE because DOE has chosen to do so. The 4-mrem limit applies to community water systems that serve at least 15 connections or regularly serve an average of at least 25 individuals daily at least 60 days out of the year. Dose limits are based on intake of two liters per day for 365 days per year, and to water supplies operated by DOE and DOE contractors.

The existence of a threshold dose is unknown. For the purposes of radiological protection, there is no practical alternative to assuming a linear relationship between dose and effect, that doses act cumulatively, and that any exposure to radiation entails a risk of deleterious effects. The ALARA requirement has been met when additional costs and exposures, that would result from improved protection, are greater than the detriment of the exposure that would be prevented. In practice, compliance with the regulatory dose limits must be achieved.

As stated earlier, the ALARA approach is now required for DOE activities and facilities that could result in public doses. DOE Order 5400.5 lists several factors that should be considered in an ALARA program. Quantitative cost-benefit analysis of many of these factors can be both expensive and difficult. Therefore, flexibility is given in the Order to perform qualitative ALARA analysis in those instances where doses are well below the limits, and when requirements of the National Environmental Policy Act (NEPA) have been met. Detailed analysis of a quantitative nature are definitely required, however, when potential doses approach the limit.

ALARA can require judgement with respect to what is reasonably achievable. Factors to be considered in an ALARA review at a minimum shall include:

- The maximum dose to members of the public
- The collective dose to the population
- Alternative processes, such as alternative treatments of discharge streams, operating methods, or controls
- Doses for each process alternative
- Costs for each of the technological alternatives
- Examination of the changes in cost among alternatives

- Changes in societal impact associated with process alternatives, e.g., differential doses from various pathways
- Potential doses from accidents, as well as, expected doses from operations

The primary method used to maintain radiation exposure and releases ALARA shall be physical design features (radiological engineering, e.g., confinement, filtration, scrubbing, treatment, and shielding). Administrative controls and procedural requirements should be employed only as supplemental methods. The use of proper design assures that the facility can be safely operated from a public and environmental viewpoint, and that maintenance, modifications, and decommissioning can be done without contamination or radiation exposure that could have been precluded through design. DOE has issued *DOE Guidance on the Procedures in Applying the ALARA Process for Compliance With DOE 5400.5.*

DOE now requires tightened controls on the discharge of liquid effluents from its facilities. The objective is to protect resources such as land, surface water, and groundwater from undue contamination. This has created the need for an evaluation of BAT. According to DOE Order 5400.5, a BAT review is required for liquid wastes containing radionuclides discharged to surface waters if these waters would contain, at the point of discharge and prior to dilution, radioactive material at an annual average concentration greater than the DCGs (listed in Chapter III) for liquids. For multiple releases, the sum of fractions method is used wherein the concentrations of radionuclides are divided by the respective DCG, and their sum is compared to the number one (meaning the sum of fractions cannot exceed one).

Several factors affect the BAT review, including: the age of the facility; cost; and environmental, safety, and public impacts. At the present time, there is an exemption for tritium, since no known practicable method is available for removing tritium from waste streams. DOE issued an interim final report, DOE/EH-263T*, Implementation Manual for Application of Best-Available Technology Processes for Radionuclides in Liquid Effluents*, in June 1992 to provide guidance and explanation of the requirements for BAT effluent control found in DOE Order 5400.5.

To prevent the buildup of radioactivity in sediment to unacceptable levels, limits exist for the levels of alpha and beta-gamma settleable solids found in a liquid process waste stream released to natural waterways.

For gross alpha: <5 picocuries per gram *(*pCi/g)

For gross beta: <50 pCi/g

To protect native animal aquatic organisms, the absorbed dose from exposure to radioactive material in liquid wastes discharged to natural waterways must not exceed 1 rad (0.01 gray) per day. This limit is based on information contained in National Council on Radiation Protection and Measurements (NCRP) Report #109, *Effects of Ionizing Radiation on Aquatic Organisms*. (An absorbed dose is the energy absorbed by matter from ionizing radiation per unit mass of irradiated material at the place of interest in that material. The absorbed dose is expressed in units of rad or gray [Gy].)

The use of soil columns (trenches, cribs, ponds, drain fields, etc.) for retaining, by sorption or ion exchange, suspended or dissolved radionuclides from liquid waste streams, must be phased out and replaced by an acceptable alternative. Each facility is responsible for developing a plan and schedule for alternate disposal methods.

The BAT selection process is implemented not just for liquid discharges to surface waters (as noted above), but also for releases to sanitary sewers where radionuclide concentrations, averaged monthly, would otherwise be greater than 5 times the DCG values for liquids (given in Chapter III) at the point of discharge.

In the codification of DOE Order 5400.5 to 10 CFR 834, total curie (Ci) limits, above background, may apply. These limits (as stated in the draft version of 10 CFR 834) are:

- 5 Ci hydrogen-3
- 1 Ci carbon-14
- 1 Ci all other radionuclides

Compliance with the dose limits in the Order are demonstrated through documentation and record keeping, effluent monitoring, environmental surveillance, dose conversion factors, EPA-approved computer models, comparison with DCG values, and other methods with the approval of the Assistant Secretary for Environment, Safety and Health (EH-1).

Chapter III, Derived Concentration Guides (DCGs) for Air and Water

The DCG values listed in this chapter are provided as guideline reference values for establishing radiological environmental protection programs at operational DOE facilities and sites. DAC values for occupational intake of radionuclides through inhalation can be found in the appendices to 10 CFR 835.)

DCG values are included for each of three exposure modes: ingestion of water, inhalation of air, and immersion in a gaseous cloud. Other potentially significant exposure pathways are not included in this chapter; therefore, specific pathway analysis would have to be performed for calculating public radiation doses.

Since the DCG values are based on a committed effective dose equivalent (CEDE) of 100 mrem, comparison with the drinking water limit of 4 mrem is accomplished by taking 4% of the DCG values for ingestion. A CEDE is the sum of the committed dose equivalents to various tissues in the body, each multiplied by the appropriate weighting factor. The CEDE is expressed in units of rem or sievert.

Chapter IV, Residual Radioactive Material

This chapter provides radiological protection requirements and guidance for the cleanup of residual radioactive material and the management of the resulting wastes, residues, and release of property. The criteria for cleanup of residual radioactive material used in this chapter originally applied to sites under the Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Surplus Facilities Management Program (SFMP). These criteria now apply DOE-wide.

Residual radioactive material, as used in this chapter, includes residual concentrations of radionuclides in soil, airborne concentrations of radon progeny, external gamma radiation levels, surface contamination limits, and radionuclide concentrations in air or water resulting from or associated with any of the above.

The basic dose limit for the public from exposures above natural background levels is 100 mrem (1 mSv) EDE. This limit applies to all sources and all release pathways from the facility or site in question including residual radioactive material. Separate limits apply to radon and its progeny.

For soil, residual concentrations of radioactive material are defined as those concentrations exceeding background concentrations when averaged over 100 square meters. Generic guidelines, i.e., guidelines independent of the property that, therefore, apply to all facilities, are taken from existing radiation protection standards. For the radionuclides radium-226 (Ra-226), radium-228 (Ra-228), thorium-230 (Th-230), and thorium-232 (Th-232), the generic values are:

- 5 pCi/g averaged over the first 15 cm of soil below the surface.
- 15 pCi/g averaged over succeeding 15 cm layers of soil more than 15 cm below the surface.

Guidelines for residual concentrations of other radionuclides are derived by environmental pathway analysis using specific property data. Information on applications of the guidelines and requirements of the Order, including procedures for deriving specific property guidelines for allowable levels of residual radioactive material from basic dose limits, is contained in DOE/CH-8901, *A Manual for Implementing Residual Radioactive Material Guidelines, A Supplement to the U.S. DOE Guidelines for Residual Radioactive Material at FUSRAP and SFMP Sites*, June 1989. Site-specific release limits require a pathway analysis utilizing specific property data and the computer program *RESRAD*, which was developed by the Argonne National Laboratory. Hot-spot criteria also exist.

Limits for airborne radon decay products are taken from 40 CFR 192, *Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings*. The objective of the remedial action is to achieve an annual average (or its equivalent) of 0.02 working level (WL), including background attributed to residual radioactive material. In no case shall the radon progeny concentration exceed 0.03 WL (including background). (A WL is roughly 10,000 Bq/m^3 or 10,000 dps/m^3 of air. A 0.02 WL is roughly 1,200 dpm/m^3 of air.)
The limit for external gamma radiation (taken as an average level above background) is 20 µR/h inside a building or habitable structure on a site to be released without restrictions. This value similarly comes from 40 CFR 192.

Surface contamination guideline values, expressed in typical units of dpm/100 cm^2, are detailed in the table that follows. These guidelines were adapted by DOE from U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86, *Termination of Operating Licenses for Nuclear Reactors* (1974), and the NRC publication, *Guidelines for Decontamination of Facilities and Equipment Prior to Release for Unrestricted Use or Termination of Licenses for By-product, Source, or Special Nuclear Material* (1982). The guideline values are applicable to existing structures and equipment.

Surface Contamination Guidelines

Allowable Total Residual Surface Contamination (dpm/100 cm^2)			
Radionuclides	**Average**	**Maximum**	**Removable**
Transuranics, I-125, I-129, Ra-226, Ac-227, Ra-228, Th-228, Th-230, Pa-231	100*	300*	20*
Th-Natural, Sr-90, I-126, I-131, I-133, Ra-223, Ra-224, U-232, Th-232	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay product; alpha emitters	5,000	15,000	1,000
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000	15,000	1,000

** DOE O 5400.5 tabulates these figures as "Reserved." The values stated here are based on a memorandum dated 11/17/95 from Mr. Andrew Wallo (EH-412).*

The Order establishes authorized limits for residual radioactive material that should be set equal to the generic or DCGs, unless it can be shown that the guidelines are not appropriate for use at the specific property.

Residual radioactive material must also be managed. DOE Order 5400.5 discusses several ways this can be achieved.

- Interim storage - Control and stabilization features shall be designed to provide for a minimum life of 25 years and an effective life of 50 years. Provisions for the control of Rn-222 and groundwater concentrations, quantities of residual radioactive material, site access, and use of onsite material must be established.
- Interim management - Generally applies when the residual radioactive material is in inaccessible locations and would involve a significant financial burden to remove.
- Long-term management - For uranium, thorium, and their decay products, control and stabilization features shall be designed to provide for a minimum life of 200 years and an effective life of 1,000 years. Control of Rn-222 emanation rates, groundwater concentrations, residual radioactive material, site access, and the use of contaminated onsite material must be established. The long-term management of other radionuclides is conducted under the provisions of DOE 5820.2A, *Radioactive Waste Management*.

Supplemental limits or exceptions can be requested in certain circumstances where the guidelines or authorized limits established for the site in question are not appropriate. Supplemental limits can allow uncontrolled release of the site without radiation restrictions; however, the basic dose limit of 100 mrem must still be achieved. Exceptions require that some restrictions be placed on the site (no farm use, for example). Any exceptions must be justified and ensure that the basic public dose limits are met. Control of residual radioactive material must still be established.

DOE Order 5480.4, *Environmental Protection, Safety and Health Protection Standards*	
Purpose	Specifies and provides requirements for the mandatory environmental safety and health (ES&H) standards applicable to DOE and DOE contractor operations; provides a listing of reference ES&H standards; and identifies the sources of the mandatory and reference ES&H standards.
Scope	DOE elements and DOE contractors
Requirements/ Key Words	• Provides a listing of reference ES&H standards. • Identifies the sources of the mandatory and reference standards.

Environmental safety and health (ES&H) requirements for facility design, construction, operation and decommissioning are given in DOE Order 5480.4, *Environmental Protection, Safety and Health Protection Standards*. The basis for the standards given in DOE Order 5480.4 are generally Environmental Protection Agency (EPA), Occupational Safety and Health Association (OSHA), Nuclear Regulatory Commission (NRC) and American National Standards Institute (ANSI) environmental safety and health standards, which are cited in four attachments to the Order. Attachment 1 is statutory requirements, Attachment 2 is mandatory policy requirements, Attachment 3 is reference standards, and Attachment 4 is sources of standards. Mandatory standards define the

minimum compliance requirements applicable to activities conducted by DOE and its contractors. Reference standards are guides and standards under consideration as guidance documents, and serve to complement mandatory standards.

DOE Order 5480.4 has a three-fold purpose: 1) to specify and provide requirements for applying mandatory environmental protection, safety, and health standards applicable to DOE and DOE contractor organizations; 2) to list standards; and 3) to identify sources of mandatory and reference environmental safety and health standards.

DOE Order 232.1, *Occurrence Reporting and Processing of Operations Information*	
Purpose	The Order and associated manual provides detailed information for categorizing and reporting occurrences at DOE facilities. Information gathered by the system is used for analysis of the Department's performance in environmental protection, safeguards and security, and safety and health of its workers and the public. This information is also used to develop lessons learned and document events that significantly impact DOE operations.
Scope	DOE elements and DOE contractor facilities
Requirements/ Key Words	Occurrence Reporting The manual associated with this order spells out how to implement the M232.1-1 occurrence categorization, notification, reporting, and processing system, and how DOE contractors are to categorize occurrences, notify DOE, and prepare and submit Occurrence Reports. Security Requirements Classified information or Occurrence Reports shall not be entered into the Occurrence Reporting and Processing System (ORPS) database. Utilization of Reportable Occurrence Information EH-1 maintains an unclassified central database, the ORPS. Each Facility Manager should use the information from occurrences related to their facilities and similar facilities and similar facilities for trending and analysis and for early identification and correction of deteriorating conditions. Procedures Departmental elements and contractors shall develop and maintain implementing procedures for occurrence reporting, which are to be submitted to the DOE Secretarial Office for approval. Categorization of Reportable Occurrences This section categorizes occurrences into 10 groups so that DOE Field and operating contractors can understand the degree of significance associated with Unusual and Off-Normal Occurrences. The 10 groups are as follows: 1. Facility Condition 2. Environmental 3. Personnel Safety 4. Personnel Radiation Protection 5. Safeguards and Security 6. Transportation 7. Value Basic Reporting 8. Facility Status 9. Nuclear Explosive Safety 10. Cross-Category Items Instructions for Completing an Occurrence Report Includes the general and specific items to be included in the reporting of occurrences via hardcopy or electronic database - ORPS.

Occurrence Reporting

Occurrence reporting is performed in accordance with DOE Order 232.1 *Occurrence Reporting and Processing of Operations Information*. It is DOE policy to ensure that the office of the Secretary and both DOE and DOE contractor line management are kept fully informed on a timely basis of events that could adversely affect national security and safety or the safeguards and security interests of DOE.

For a detailed outline of the occurrence categories, the associated manual for DOE Order 232.1 can be found at the following web site:

http://www.explorer.doe.gov:1776/htmls/alldirectives.html

The reporting criteria, primarily related to radiation incidences under categories 04A and B, 1D, and radioactive releases under category 02, are:

- Group 1. D. Loss of control of radioactive material/spread of radioactive contamination
- Group 2. A. Radionuclide releases
- Group 4. A. Radiation exposure
  B. Personnel contamination

Group 1: D. Loss of Control of Radioactive Material/Spread of Radioactive Contamination

Unusual Occurrence

(1) Identification of radioactive contamination offsite in excess of 100 times the surface contamination levels specified in DOE Order 5400.5, Figure IV-1, that has not been previously identified and formally documented.
(2) Loss of accountability of a sealed or unsealed radioactive source that exceeds 100 times the quantities specified in DOE Notice 5400.13, *Sealed Radioactive Source Accountability*.
(3) Any fissile material in a process or nonprocess system outside primary confinement boundaries not designed or expected to accommodate such material.

Off-Normal

(1) Any unplanned spill of liquids in excess of one gallon contaminated with radioactive material in concentrations greater than five times the DCG values listed in DOE Order 5400.5, Figure III-1.
(2) Identification of radioactive contamination outside a radiological area (as defined in DOE/EH-0256T, *Radiological Control Manual*) established for contamination control, but within a controlled area, in excess of 10 times the total surface contamination levels in Table 2-2 of the *Radiological Control Manual*.

(3) Identification of radioactive contamination onsite that is not located within a controlled area, fixed contamination area, or soil contamination area, and is in excess of two times the surface contamination levels in Table 2-2 of DOE/EH-0256T, *Radiological Control Manual*.
(4) Identification of radioactive contamination offsite in excess of the surface contamination levels specified in DOE Order 5400.5, Figure IV-1, that has not been previously identified and formally documented.
(5) Loss of accountability of a sealed or unsealed radioactive source that exceeds ten times and is less than or equal to 100 times the quantities specified in DOE Notice 5400.13, *Sealed Radioactive Source Accountability*.
(6) Loss of accountability of a sealed or unsealed radioactive source that is less than or equal to ten times the quantities specified in DOE Notice 5400.13, *Sealed Radioactive Source Accountability*, may be recorded and reported in a roll-up report.

Group 2 - Environmental. A. Radionuclide Releases

Unusual Occurrence

(1) Release of a radioactive material that violates environmental requirements in Federal permits, Federal regulations, or DOE standards.
(2) Any release that is not an emergency as defined in DOE 5500 series Orders, but requires immediate reporting (less than 4 hours) to Federal regulatory authorities. Release of a radioactive material that exceeds a Federally permitted release by the amount of a Comprehensive Environmental Response, Compensation and Liability Act reportable quantity or, where no federally permitted release exists, the release exceeds the reportable quantity or triggers specific action levels for an outside Federal agency.

Off-Normal

(1) Any release of radioactive material to controlled or uncontrolled areas that is not part of normal monitored release and exceeds 50% of a Comprehensive Environmental Response, Compensation and Liability Act reportable quantity specified for such material per 40 CFR 302, *Designation, Reportable Quantities and Notification*.
(2) Any controlled release of radioactive material that occurs as a monitored part of normal operations that exceeds what historical data and/or analysis show is expected as a result of normal operations.
(3) Any monitored facility or site boundary where exposure or concentration exceeds what historical data and/or analysis show is expected as a result of normal operations.

(4) Any detection of a radionuclide in a sanitary or storm sewer, waste or process stream, or any holding points where such a material is not expected.
(5) Any controlled, uncontrolled, or accidental release not classified as an unusual occurrence, but will be reported in writing to State/local agencies in a format other than routine periodic reports.

Group 4 - Personnel Radiation Protection

A. Radiation Exposure. Unless specified otherwise, all doses listed in the following requirements are calculated as the total effective dose equivalent, which is the sum of the committed effective dose equivalent due to radionuclides taken into the body (internal exposure) and the dose equivalent due to external exposure.

Unusual Occurrence
Determination of a dose that exceeds the limits specified in Table 2-1 of DOE/EH-0256T, *Radiological Control Manual* (for onsite exposure) or DOE Order 5400.5, Chapter II, Section 1 (for offsite exposures to a member of the public).

Off-Normal
(1) Any single occupational exposure that exceeds an expected exposure by 100 mrem.
(2) A single unplanned exposure onsite to a minor, student, or member of the public that exceeds 50 mrem.
(3) Determination of a dose that exceeds the limits specified in DOE Order 5400.5, Chapter II, Section 7, for offsite exposures to a member of the public.

B. Personnel Contamination

Unusual Occurrence
(1) Any single occurrence resulting in the contamination of five or more personnel or clothing (excluding protective clothing) measured in accordance with the *Radiological Control Manual*, Article 338 (prior to washing or decontamination), at a level exceeding Table 2-2 values for total contamination limits. The contamination level shall be based on direct measurement and not averaged over 100 cm^2.
(2) Any occurrence requiring offsite medical assistance for contaminated personnel.
(3) Any measurement of personnel or clothing contamination offsite, measured in accordance with the *Radiological Control Manual*, Article 338 (prior to washing or decontamination), at a level exceeding Table 2-2 limits for removable contamination. The contamination level shall be based upon direct measurement and not averaged over 100 cm^2.

Off-Normal

(1) Any measurement of personnel or clothing contamination (excluding protective clothing) at a level equal to, or exceeding five times the *Radiological Control Manual*, Table 2-2 total contamination limits, measured in accordance with Article 338 (prior to washing or decontamination). The contamination level shall be based upon direct measurement and not averaged over 100 cm^2.

(2) Any measurement of personnel or clothing contamination (excluding protective clothing) at a level exceeding, but less than, five times the *Radiological Control Manual*, Table 2-2 total contamination limits, measured in accordance with Article 338 (prior to washing or decontamination). The contamination level shall be based upon direct measurement and not averaged over 100 cm^2. These occurrences may be recorded and reported in a roll-up report.

Event Categorization

The facility manager or facility manager designee is responsible for event categorization within two hours of the event, in accordance with section 8 of the *Occurrence Reporting Manual,* as one of the following:

Emergencies

Emergencies are defined in the DOE 5500 series of Orders. Emergency occurrences are the most serious occurrences and require an increased alert status for onsite personnel and in specified cases, for onsite personnel and in specified cases, for offsite authorities.

Unusual Occurrences

An Unusual occurrence is a nonemergency occurrence that exceeds the off-normal occurrence threshold criteria; is related to safety, environment, health, security, or operations; and requires immediate notification to DOE.

Off-Normal Occurrences

Off-normal occurrences are abnormal, or unplanned, events or conditions that adversely affect; potentially affect; or are indicative of degradation in the safety, safeguards and security, environmental or health protection, performance or operation of a facility.

Notifications

Notification of unusual occurrences should be done in accordance with DOE Order 232.1. The facility manager should be notified of unusual occurrences. Within two hours of categorization the facility manager notifies the following:

- DOE Facility Representative
- DOE HQ Emergency Operations Center (EOC)

DOE Facility representative notifies the:

- Head of the Field Element

DOE HQ EOC notifies the:

- DOE Program Manager

DOE Program Manager notifies the:

- Secretarial Officer

The health physicist may be involved in identifying a reportable event in cases of a release of radioactive material and/or contamination and significant radiation exposures. The health physicist may be called upon to calculate either internal or external doses. The magnitude of release/dose may determine categorization of the event.

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*	
Purpose	To provide requirements and guidelines for Departmental elements to use in developing directives, plans, and/or procedures relating to the conduct of operations at DOE facilities. The implementation of these requirements should result in improved quality and uniformity of operations.
Scope	DOE elements and DOE contractor

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*	
Requirements/ Key Words	Chapter I, Operations Organization and Administration DOE facility policies should describe the philosophy of standards of excellence under which the facility is operated, and clear lines of responsibility for normal and emergency conditions are established. Chapter II, Shift Routines and Operation Practices Standards for the professional conduct of operations personnel should be established and followed so that operator performance meets the expectations of DOE and facility management. This chapter describes important aspects of routine shift activities and watch standing practices. Chapter III, Control Area Activities Control area activities should be conducted in a manner that achieves safe and reliable facilities operations. Guidelines are presented for control area access, professional behavior, and monitoring control panels and equipment. Chapter IV, Communications Important guidelines for a plant program for audible communications including emergency communications systems, public address (PA) systems, contacting operators, and radios. Chapter V, Control of On-Shift Training On-shift training should be conducted so that the trainee satisfactorily completes all of the required training objectives and receives maximum learning benefits. Includes documentation of instructor qualifications, supervision and control of trainees. Chapter VI, Investigation of Abnormal Events A program for the investigation of abnormal events should ensure that facility events are thoroughly investigated to assess the impact of the event, to determine the root cause of the event, and to ascertain whether the event is reportable to DOE in accordance with DOE Order 232.1. Chapter VII, Notifications Guidelines to ensure timely notification of appropriate DOE personnel and other agencies, when required, should be employed to ensure that the facility is responsive to public health and safety concerns. Chapter VIII, Control of Equipment and System Status Overall guidelines on good operating discipline, should ensure that facility configuration is maintained in accordance with design requirements. The operating shift should know the status of equipment and systems.

DOE Order 5480.19, *Conduct of Operations Requirements for DOE Facilities*	
Requirements/ Key Words (cont.)	Chapter IX, Lockouts and Tagouts The important elements of a lockout/tagout program. DOE is intended to meet the requirements of 29 CFR 1910, Title Chapter X, Independent Verification Guidelines to provide a high degree of reliability in ensuring the correct facility operations and the correct position of components such as valves, switches, and circuit breakers. Chapter XI, Log Keeping Records should contain a narrative log of the facility's status and all events, as required, to provide an accurate history of facility operations. Chapter XII, Operations Turnover Guidelines for the important aspects of a good shift turnover, including checklists, and control panel walkdowns. Chapter XIII, Operations Aspects of Facility Chemistry and Unique Processes Operational monitoring of facility chemistry or unique process data and parameters should ensure that parameters are properly maintained. Chapter XIV, Required Reading Proper use of a required reading file by operations personnel should ensure that appropriate individuals are made aware of important information that is related to job assignments. Chapter XV, Timely Orders to Operators Key features for a means of operations management to communicate short-term information and administrative instructions to operations personnel. Chapter XVI, Operations Procedures Operations procedures should provide appropriate direction to ensure that the facility is operated within its design bases and should be effectively used to support safe operations of the facility. Chapter XVII, Operator Aid Postings Operator aid programs should be established to ensure that operator aids, which are posted, are current, correct, and useful. Chapter XVIII, Equipment and Piping Labeling Well established and maintained labeling program to ensure that facility personnel are able to positively identify equipment they operate, in accordance with OSHA regulations.

Conduct of Operations

Radiological controls fall under the operation of a facility and, therefore, DOE Order 5480.19 applies to the radiological control organization. The following is taken from DOE Order 5480.19 regarding the conduct of operations.

A high level of performance in DOE operations is accomplished by: establishment of high operating standards by management, communicating operating standards to the working level, providing sufficient resources to the operations department, ensuring personnel are well trained, closely monitoring performance in operations, and holding workers and their supervisors accountable for their performance in conducting activities.

Senior management establishes operating standards, considering input from the working level when appropriate. The working level will more eagerly support the standards when they have had input into the development of those standards. The standards should define operating objectives, establish expected performance levels, and clearly define responsibility in plant operations. Standards for operating activities should also be integrated into procedures and programs. Operating standards should also be communicated to the working level by training workers in operating practices and by supervisory monitoring and guidance of work. Sufficient staff, equipment, and funding should be allocated to permit the operations department to effectively perform its functions.

Performance in operations should be closely monitored by facility management, and operating reports and goals should be used so that the performance of the operating department can be effectively measured. Operations personnel should be held accountable for their performance through supervisory counseling, performance appraisals, and, when necessary, disciplinary measures. Remedial training should be provided when appropriate.

Operations Policies

Procedures or other definitive documentation should specify policies that are to be applied to operations. These policies should specify goals and the means to achieve those goals. These documents should also provide for the types of controls necessary to implement policies as discussed in this and other chapters of the guidelines.

Operating procedures should be based upon facility and DOE guidance for operations. Responsibilities for implementing these policies, including the responsibility of shift personnel, if applicable, should be clearly defined. Operations personnel should clearly understand their authority, responsibility, accountability, and interfaces with other groups. Physical security should be in accordance with DOE 5630.11, *Safeguards and Security Program*.

Resources

The operations supervisor for DOE facilities should be provided with sufficient resources in materials and personnel to accomplish assigned tasks without requiring excessive overtime by the operations staff. These resources should include technical personnel needed to support the operations. A long-range staffing plan that anticipates personnel losses should be developed and implemented.

Monitoring of Operating Performance

As described in Chapter VI of DOE Order 5480.19, operating problems should be documented and evaluated. Based on assessments of these problems, corrective actions should be taken to improve the performance of the operations department performance. Additionally, frequent direct observation of operations activities by supervisors and managers is essential to monitoring operations performance.

Safety, environment, and operating goals should be used as a management tool for involving cognizant groups or individuals in improving operating performance and for measuring operating effectiveness. Operations goals in areas, such as the following, should be established:

- ALARA
- Achieving and maintaining complete staffing and training of shift positions
- Timely completion of scheduled surveillance
- Minimizing:
  - Waste
  - Personnel errors
  - Lost facility capability
  - The amount of overtime
  - The unavailability of safety systems
  - The number of lighted annunciators
  - The number of unscheduled facility shutdowns per year

Goals should be auditable, measurable, realistic, and challenging. An action plan to meet the goals should be developed with input from personnel involved in conducting operations, reviewed by the operations supervisor, and approved by management. The progress toward completing the action plan and achieving goals should be monitored periodically. If results show a significant variance from the desired progress in achieving goals, management should review the action plan to ensure that it is adequate and being executed. An audit of performance, relative to operating goals, should be provided to facility management and DOE. This summary should include an explanation of performance and actions planned to improve future performance.

Operating and safety goals should be set and used as motivators for improvement, not as ends in themselves. The purpose is not simply to meet a numerical goal; rather, the purpose is to improve operating performance. Meaningless goals (i.e., goals that are easy to meet with little action) should not be used.

Inspections, audits, reviews, investigations, and self-assessments are essential to compliance, prevention, and feedback in an operating program. Line managers and supervisors should perform routine observations of personnel performing operating activities. Identified deficiencies should be documented, trended, and corrected. Also, other groups, such as quality assurance personnel, should periodically review and assess operating performance. These reviews can assist line managers and supervisors in identifying and correcting problems.

Accountability

Workers and their supervisors should be held accountable for operating performance. Personnel involved in significant or frequent violations of operating practices should be counseled, retrained, and disciplined, as appropriate. Supervisor performance appraisals and promotions should include an assessment of operating performance.

Management Training

Formalized supervisory and management training should be incorporated into training programs. This is especially important to the first-line supervisors on shift and should aid them in managing shift activities.

Planning for Safety

Facility guidance, which describes safety preplanning requirements for all operational activities should exist. The guidance should explain the role of safety analysis reviews, job safety analysis, and the handling of safety matters. All operations personnel should understand the safety planning requirements.

DOE/EH-0256T (Revision 1), *Radiological Control Manual*	
Purpose	**NOTE:** The *Radiological Control Manual* was initially issued as a requirements document for all DOE facilities to follow with respect to radiation protection. It is now considered a guidance document and is in the process of being revised as a technical standard. • Establish and maintain a system of regulatory policy and guidance reflective of national and international radiation protection standards and recommendations. • Ensure that personnel responsible for performing radiological work activities are appropriately trained. • Ensure the technical competence of personnel responsible for implementing and overseeing the radiological controls program. • Establish and maintain, from the lowest to the highest levels, line management involvement and accountability for departmental radiological performance. • Ensure that radiological measurements, analyses, worker monitoring results, and estimates of public exposures are accurate and appropriately made. • Conduct radiological operations in a manner that controls the spread of radioactive materials, reduces exposure to the workforce and the general public, and utilizes a process that seeks exposure levels as low as reasonablely achievable. • Incorporate dose reduction, contamination reduction, and waste minimization features into the design of new facilities and significant modifications to existing facilities in the earliest planning stages. • Conduct oversight to ensure that departmental requirements are being complied with and appropriate radiological work practices are being implemented.
Scope	All Departmental elements.
Requirements/ Key Words	Chapter 1 Excellence in Radiological Control Chapter 2 Radiological Standards Chapter 3 Conduct of Radiological Work Chapter 4 Radioactive Materials Chapter 5 Radiological Health Support Operations Chapter 6 Training and Qualification Chapter 7 Records

The *Radiological Control Manual* offers detailed guidance for implementation of radiation protection programs in DOE. It establishes practices for the conduct of DOE radiological control activities and states DOE's positions and views on the best course of action currently available in the area of radiological controls. This manual is intended to be reissued as a technical standard. The use of "shall" statements presently in the document will presumably be changed to "should" statements.

The DOE radiation protection program (RPP), the contractor site-specific *radiological control manual* or procedures manual, site implementation plans, and the site contract with DOE, place the requirements on the facility. The facility radiation protection personnel are then responsible for carrying out daily activities that ensure compliance with all of these radiological requirements.

In the Fall of 1995, *the Radiological Control Manual* ceased to function as a requirements document for all DOE and contractor radiation protection organizations. However, contractors whose contract stipulates compliance with the manual must continue to comply until the applicable contract is amended.

Anyone involved in radiological work is responsible and accountable for radiological control. To be held accountable, radiological workers must be informed, disciplined, and have a cautious attitude towards radiation and radioactivity. Basically, radiation protection personnel are responsible for implementation of the *Radiological Control Manual* guidance and requirements at their sites.

3. SELF-STUDY SCENARIOS/ACTIVITIES AND SOLUTIONS

Scenario 1, Part A

At Facility X, the administrative control level is 500 mrem per year. A technician entered a radiologically controlled area to perform work that was infrequently conducted. The technician signed in on a Radiological Work Permit (RWP) before entering the area and proceeded to the work area. When the technician had finished his work and was leaving, he looked at his self-reading dosimeter (0 to 200 mR/hr) and discovered it was off scale. The technician immediately notified the radiological control technician (RCT).

What are the actions the RCT should perform?

Scenario 1, Part B

From the RCT's investigation, the following issues were identified:

- The technician's radiological training had not been updated.
- The technician had no prejob briefing, but was simply informed to perform the work.
- The technician signed in on the wrong RWP.
- Based on the prejob estimate:
  - The technician stayed in the area longer than was anticipated.
  - The RCT expected that the technician would receive a dose of 200 mrem.
  - The technician should have been provided additional dosimetry such as a self-reading dosimeter covering a wider exposure range than the one issued.
- The technician's actual dose of 270 mrem (from the TLD reading) was greater than the expected dose of 200 mrem.

What sections of the *Radiological Control Manual* address the issues in Part A and Part B of Scenario 1?

Scenario 2, Part A

A trained Rad Worker I detected contamination on his hands while exiting a work area. A RCT was called. The RCT determined that there were three other workers who were involved in the same work that day. Of the three, one had already gone home. The worker with the contaminated hands was decontaminated. What are the actions the RCT should perform?

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Scenario 2, Part B

The RCT detected two small areas of alpha contamination measuring 1,200 dpm on the heel of the employee's personal shoe and 300 dpm on the employee's right pants leg. A follow-up investigation by the RCT revealed:

- The employee entered a posted contamination area without reading the radiological postings.
- The postings were obscured.
- The employee entered the posted contamination area without wearing protective clothing.
- The employee had not signed the RWP.
- The employee had left the area and site without performing whole body frisking.
- The employee had not had the proper level of Rad Worker training.

What are the actions the RCT should perform?

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Scenario 2, Part C

In Scenario 2, parts A and B, what Articles of the *Radiological Control Manual* address the issues presented?

Scenario 3

A DOE contractor, whose primary missions involve medical research and training, maintains six buildings that contain radioactive material. The hazards associated with operations involving these materials are viewed as minimal and could be characterized as those similar to an academic research setting. The majority of the radioactive material at the contractor's facility consist of sealed sources, iodine-131, tritium, and carbon-14 labeled compounds, with a typical annual inventory in the microcurie to millicurie range. In performing their mission for DOE, the contractor's employees routinely receive occupational exposures that are less than 100 millirem annually.

The contractor's facility was established in the 1980s with a workforce of 500. The original facility design criteria was for medical research and training. Today, the contractor employs 750 full-time employees, 50 of which are monitored radiation workers. The facility is located in a population center of 500,000.

You have been tasked with conducting an assessment of this facility's radiation protection program to ensure its compliance with radiation protection requirements. What are the steps you must take to complete this task?

Scenario 4

During the assessment, the following data was gathered.

- The survey instruments had been calibrated 1.5 years ago.
- A random sample of the training and qualification records indicated that retraining had not been done for 2.5 years.

During the interview with the radiological control manager, the following questions were asked and replies given:

- How are requirements for entry into a radiation area determined?

  Answer: Strictly from the regulations. For example, 10 CFR 835.

- How do you know the current requirements for qualification are kept up-to-date?

  Answer: I depend on my radiological control supervisor to keep up with this information.

During the interview with the radiological control supervisor, the following questions were asked and replies given:

- How are requirements for entry into a radiation area determined?

  Answer: From what we determine is the important thing to do.

- Are qualification requirements identified for all positions in the operating organization?

  Answer: I'm not sure, but my radiological control people are up-to-date on their radiological control qualifications.

During the interview with a random sample of radiation workers, the following question was asked and reply given.

- When did you receive your last radiation dose report?

  Answer: About two years ago.

During the assessment, the following situation was observed:

Rad workers "1" and "2" approached a posted radiological area. Both workers were carrying a canned drink and Worker "2" was chewing gum. Worker "1" was heard to say, "Do you have the RWP?" Worker "2" replied, "I thought you had it." Worker "1" was then heard to ask, "Where is the RCT?" The reply was, "I haven't seen her."

Worker "1" was then observed pulling out his pocket dosimeter and reading it. He also asked Worker "2" where his dosimeter was. Worker "2" responded, "I forgot it; I'll just use your reading." During this interchange, Worker "1" was observed taking a swallow of his drink and placing the can on the floor.

The workers entered the radiological area with Worker "2" carrying his drink, which he placed on the floor next to the door. Next, Worker "2" was seen sticking his chewing gum to a pipe support. Worker "1" noticed that the green isolation valves were open and told Worker "2." Worker "2's" response was, "So, close them." Worker "1" closed the valve while remarking to Worker "2," "I wish we had been trained to work on this valve. It sure would be easier if we knew what we were doing and had received some type of briefing." Worker "2" responded, "No big deal, we can wing it."

The workers continued working with the valve. Worker "2" stopped his work and asked Worker "1" if he had seen the replacement valve. Worker "1" pointed to the valve outside the area and replied, "I'll go get it."

Worker "1" was seen leaving the radiological area to get the valve. Upon returning to the radiological area with the valve, the worker kicked over the canned drink inside the area. He handed the valve to Worker "2" and was heard to remark, "My mouth is sure dry." Worker "2" offered him a piece of gum and Worker "1" accepted it, unwrapped it, and started chewing it.

Given this information, analyze the results of the assessment to determine contractor compliance or noncompliance with the requirements.

Scenario 5

Given the results from the analysis of the above data, document and communicate the results to contractor and departmental line management.

Scenario 6

You have been assigned to work with an architect in the design of a new wing of your processing building. Because of a specific design configuration, it may be necessary for a radiological worker to enter a radiological-controlled area for the purpose of making physical adjustments to the sensors of a number of gauges over the course of a calendar year; without such periodic adjustments, calibration of gauges cannot be maintained. Redesign of the system at this point would be cost prohibitive, especially since the process may be discontinued within the next year or so. Such adjustments, would, however, depending upon the time they take, result in additional radiation exposure to workers of up to 5 rem per visit. How is this situation addressed in 10 CFR 835, and in the *Radiological Control Manual,* and how would you implement it in respect to your RPP and site implementation plan?

Answers to Scenarios

Scenario 1, Part A, Solution
(Any reasonable paraphrase of the following is acceptable.)

The actions the RCT should perform include the following:

- Pull the technician's dosimetry.
- Restrict the technician from radiological area access pending the reading of his thermoluminescent dosimeter (TLD).
- Conduct an investigation looking at the following:
  - The RWP.
  - The prejob estimate and the prejob briefing.
  - The procedure for the work that was to be completed.

Scenario 1, Part B, Solution
(Any reasonable paraphrase of the following is acceptable.)

The sections of DOE/EH-0256T (Revision 1), *Radiological Control Manual*, address the following issues:

- Article 211, defines an administrative control level of 2,000 mrem per year per person. In this case, the facility adopted an administrative control level of 500 mrem, which is considered to be a "challenging and achievable" level according to the *Radiological Control Manual*. As noted in this scenario, the worker received less than this dose limit.
- Article 313 discusses the attention and planning that should be promoted for infrequent or first-time operations. Included in this would be an ALARA review by an appropriate committee and increased line and management oversight. It is conceivable that additional prejob planning might have limited the worker's exposure to less than prejob estimates.
- Articles 321 and 322 provide typical information that should be included on a RWP and the uses of RWP, respectively.
- Articles 631 to 633 discuss the Radiological Worker Training requirements for access to radiological areas.

- Article 641 advocates training not only for normal or routine operations, but also situations where radiological conditions change during the course of performing a particular work function. Dose rates, for example, could increase as the job proceeds, underscoring the importance of recognizing, evaluating, and anticipating changing conditions that could affect a worker's exposure. Training requirements for radiological control technicians and supervisors are specified in Articles 642 to 644.

Scenario 2, Part A, Solution
(Any reasonable paraphrase of the following is acceptable.)

The RCT should do the following:
- Contact the employee at home and travel to his home.
- Perform radiation monitoring on the employee, the employee's home, automobile, and any location where the employee had been after work.
- Perform surveys to identify the source of the contamination.
- Notify the radiological control supervisor to determine if the event is reportable.
- Notify the supervisor of the workers and/or the individual responsible for the work area.
- Control access to potentially contaminated areas.
- Maintain control of contaminated clothing or equipment.

Scenario 2, Part B, Solution

The RCT and employee should remove and properly bag the contaminated articles. The RCT should:
- Resurvey the employee.
- Take nasal smears from each employee involved.
- Write an incident report.
- Inform supervisor/radiological control manager/facility manager.
- Determine source of contamination.

Scenario 2, Part C, Solution

Articles of the, *Radiological Control Manual*, address the following issues:
- Chapter 1, "Excellence in Radiological Control," provides guidance in the establishment and maintenance of control programs. Workers, for example, should have a proper regard for radiation and the use of radioactive materials (Article 122). Worker responsibilities are detailed in

Article 123. In this scenario, the worker in question violated procedures that, in effect, resulted in a loss of control of radioactive material, and a situation where the general public could have been adversely affected. This particular worker had completed Rad Worker I training; however, according to Article 632, this level of training is not sufficient to allow a worker to enter contamination (and other) areas. Article 613 discusses training requirements for Rad Worker I workers, including time lines for retraining and refresher training. Retraining should be strongly considered in this case. Requirements for entry into contamination areas are specified in Article 335. This Article reiterates that Rad Worker I training is not sufficient to allow access.

- Articles 335 and 338 also state that whole-body frisking be performed when exiting a contaminated area. Radiation monitoring was not performed in this instance.
- The use of a RWP is covered in Article 322, which notes that the RWP shall be signed prior to entry.
- Article 231 discusses posting requirements and their purpose. The fact that the posting was obscured is a complicating factor in this scenario and violated this Article of the *Radiological Control Manual*.
- Personal protective equipment and clothing is required under Article 325 for entry into a contaminated area. This worker wore no protective clothing.
- Article 541 discusses handling personnel with radiologically contaminated skin.

NOTE: Actions or situations were combined to create new incidents from the following references:

- *Operating Experience Weekly Summary 96-05*, January 26 through February 1, 1996. Event number 4.
- *Operating Experience Weekly Summary 96-09*, February 24 through February 29, 1996. Event number 4.
- *Operating Experience Weekly Summary 96-10*, March 1 through March 7, 1996. Event number 9.

Scenario 3, Solution
(Any reasonable paraphrase of the following is acceptable.)

Step 1 Prepare an action plan.
Step 2 Conduct the assessment using the action plan developed.
Step 3 Communicate the results to the contractor and departmental line management.

When preparing for the assessment and preparing the action plan, consideration should be given to the following:

1. Decide if you are going to conduct an announced or an unannounced assessment. Announced assessments are scheduled through a preassessment memorandum. Unannounced assessments are used to determine "real" program performance.

2. Review upper-tier procedures describing the radiological control program. Perform document reviews of:
   - Operating procedures
   - Records for:
     - Dosimetry
     - Work control RWP
     - Surveys (contamination, radiation level, air, special)
     - Occurrence reports, deficiency reports, and critiques
     - Regulatory reports
     - Radioactive effluent reports
     - Training and qualification
     - Instrument calibration and response testing
   - Special studies

3. Conduct a short (one hour or less) tour of the site/facility.
   - Tour site/facility, preferably with an experienced individual from the site.
   - Make notes of housekeeping and facility condition. Items to look for include:
     - Leaks, spills
     - Dirt, rust, and clutter
     - Poor equipment maintenance
     - Radiological control posting
     - Radiological control technician (RCT)/radiological worker interface
     - Employee morale

4. Interview radiological control organization staff and "customers."
   - Radiological control manager
     - Knowledge of current radiological control regulations and industry standards
     - Identification of program deficiencies and priorities
     - Obstacles to improving program performance
   - Radiological control supervisor(s).
     - Level of support given radiological control program and radiological control manager
     - Identification of program deficiencies and priorities
     - Obstacles to improving program performance

   NOTE: Compare responses from the radiological control manager and supervisor(s).

   - Radiological control staff members responsible for major technical functional areas. Examples of these functional areas include:
     - Organization and administration
     - Personnel training and qualification
     - Quality assurance
     - ALARA
     - Radiological work control
       + Procedures
       + RWPs
     - Posting and labeling
     - Radioactive material control
       + Source control
       + Release of materials
       + Receipt and transportation
     - Entry control
     - Contamination control
     - Instrumentation alarms
     - Monitoring
       + Workplace
       + Effluent
       + Environmental
     - Dosimetry

  + External
  + Internal (bioassay)
- Respiratory protection
- Facility-specific features
  + Tritium
- Radioactive waste management
- Emergency response
- Records
- Assessments/performance indicators

NOTE: Document their responses to incidents in their technical area.
Discuss impediments to improving their programs.

- Qualified RCTs
  - The depth and breadth of knowledge of radiation protection
  - Technical issues unique to the site/facility
  - Effectiveness of the working relationship between RCTs and their "customers"
- Radiological control program "customers"
  - Knowledge of fundamental radiation protection concepts and good radiological worker practices
  - Working relationship with the RCTs
  - Obvious or hidden problems
  - Poor communications
  - Division of work problems
  - Overall, how the radiological control organization is regarded ("policeman" or team member)

5. Observe radiological workers/RCTs in the workplace.
   - Recommendations for observing work include:
     - Dress as the individuals being observed
     - Work the same hours they work
     - Stand away from the immediate work area, but close enough to watch the work proceed
     - Resist the urge to get involved in the work
     - Be professional and courteous, but not familiar

- Key areas to watch for include:
  - Procedure violations
  - Failure to follow RWP requirements for:
    + Dosimetry
    + Protective clothing
    + Respiratory protection
    + RCT coverage
    + Surveys
    + Special instructions
  - Poor rad worker practices:
    + Reaching across radiological boundaries
    + Scratching body with gloved hand
    + Inadequate frisking
    + Loitering in a high radiation field
  - Poor housekeeping; disorderly work area
  - Wasted time and effort due to ineffective work planning
  - Communication problems
  - Poor relationships between radiological workers and RCTs

Scenario 4, Solution
(Any reasonable paraphrase of the following is acceptable.)

There are several areas where the contractor is not in compliance. Subpart E of 10 CFR 835 states that "Instruments used for monitoring and contamination control shall be periodically maintained and calibrated on an established frequency of at least once a year."

The radiological control manager should not rely on the radiological control supervisor. A report should be generated and the radiological control manager should review this report to ensure that qualifications are up-to-date.

The radiological control supervisor does not have the proper understanding of the law. Subpart F of 10 CFR 835, Entry Control Program, lists requirements for entry into a radiation area. Subpart J of 10 CFR 835, Radiation Safety Training, states that retraining shall be conducted at intervals not to exceed two years. The supervisor can be held accountable and the contractor can be fined for noncompliance under the Price-Anderson Amendments Act.

Subpart I of 10 CFR 835 states that each individual monitored, during the year, shall be provided a radiation dose report on an annual basis.

The following were activities that may be potential problems:

- Worker "2" was chewing gum.
- The workers did not have a copy of the RWP at the work site.
- There was no RCT present (RWP called for continuous coverage).
- Worker "2" carried a soft drink into the area.
- Worker "1" created a liquid spill in the radiological area.
- Worker "1" was given gum and chewed it in the area.
- The replacement valve was not initially taken into the area.
- There was no prejob briefing conducted (based on conversation).
- Green isolation valves were not closed prior to beginning work.
- The workers had no training on conducting the work.

Scenario 5, Solution
(Any reasonable paraphrase of the following is acceptable.)

Post assessment Activities

At the post assessment conference, summarize the findings identified during the assessment. This is an opportunity for additional questions about the findings. Any requests for correctable actions, dates, or a need for follow-up assessments can be identified at this time. Thank everyone for cooperation and support during the assessment.

1. Publish assessment findings.
2. Receive site responses, which should include the following:
    - Action items
    - Responsible individuals/groups
    - Action item due dates
3. Accept/reject/modify responses.
4. Develop corrective action tracking list.
5. Publish a periodic action item status report.
6. Maintain a separate file of open action items.

7. Personally verify the closure of action items.
8. Evaluate the adequacy of actions taken to close open findings:
    - Has root cause been correctly identified and corrected?
    - Are follow-up assessments needed?

Scenario 6, Solution
(Any reasonable paraphrase of the following is acceptable.)

The *Radiological Control Manual* addresses the fact that a worker may receive a dose in excess of 5 rem per year (including all exposure up to the time of a planned special exposure) (as per 10 CFR 835, section 204). Exceptions to this may be granted under extraordinary situation (as per the *Radiological Control Manual*, Article. 213.3.a.-b.) This situation would qualify as extraordinary since redesign of the system would be theoretically cost prohibitive.

The conditions of a planned special exposure would have to be detailed in both the update to the site Radiological Control Manual and as an additional site implementation plan. These conditions would have to be:

- Reviewed by the radiological control manager.
- Submitted (by the contractor senior site executive) to the secretarial office.
- Approved by both the Secretarial Officer and theAssistant Secretary for Environmental, Safety, and Health.

In the process of this review, the site would have to:

- Find that no alternative actions were feasible or practical.
- Request an exception to exposure limits (for special planned exposures) in writing.
- Get site and DOE approval from proper officials (see above.)
- Determine prior exposure doses for the affected worker(s) and consider only those workers who, under this special exposure, would not exceed 5 rem in the current year.
- Obtain permission, in writing, from each worker involved.
- Inform each individual of:
    - the purpose of the planned operations
    - the procedures to be followed
    - the potential dosages that could be received
    - other associated potential risks involved

  - the specific radiological conditions anticipated
  - and any other hazards that might be encountered.
- Instruct workers on how to keep exposures ALARA.
- Keep accurate records of actual exposure levels received during the operation.
- Submit a written report to the approving organizations identified above at the conclusion of the operation.

4. SUGGESTED ADDITIONAL READINGS AND/OR COURSES

Readings

- 10 CFR 835, *Occupational Radiation Protection.*
- DOE N 441.2, *Radiological Protection for DOE Activities.*
- DOE/EH-0256T (Revision 1), *Radiological Control Manual*
  NOTE: See Appendix 3A, Checklist for Reducing Occupational Radiation Exposure, pp. 3-35 & 3-36.
- DOE Order 5480.4, *Environmental Protection, Safety, and Health Protection Standards.*
- G-10 CFR 835, Revision 1, *Implementation Guides for Use with Title 10 Code of Federal Regulations 835*.
- International Commission on Radiological Protection. *Cost -Benefit Analysis in the Optimization of Radiation Protection* (ICRP 37). New York: Author.
- International Commission on Radiological Protection. *Recommendations on the International Commission of Radiological Protection* (ICRP 60). New York: Author.
- Pacific Northwest Laboratory. (1988). *Department of Energy Health Physics Manual of Good Practices for Reducing Radiation Exposure to Levels that are As Low As Reasonably Achievable (ALARA)* (PNL-6577). Richland, WA: Author.
- Biological Effects of Ionizing Radiation (BEIR), Report V, *Health Effects of Exposure to Low Levels of Ionizing Radiation*, 1990.
- 40 CRF 264, *Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities*.

Courses

- DOE/EH-0450 (Revision 0), *Radiological Assessors Training (for Auditors and Inspectors) - Fundamental Radiological Control,* sponsored by the Office of Defense Programs, DOE.
- *Applied Health Physics* -- Oak Ridge Institute for Science and Education.
- *Health Physics for the Industrial Hygienist* -- Oak Ridge Institute for Science and Education.
- *Safe Use of Radionuclides* -- Oak Ridge Institute for Science and Education.
- *Radiation Protection Functional Area Qualification Standard* -- GTS Duratek.